

**PATENT COOPERATION TREATY
PCT
INTERNATIONAL PRELIMINARY EXAMINATION REPORT**
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference KRD-P017WO	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/SG2002/000060	International Filing Date (day/month/year) 12 April 2002	Priority Date (day/month/year) 12 April 2002
International Patent Classification (IPC) or national classification and IPC Int. CL⁷ G06K 9/00, G06K 9/32, G06K 9/46		
Applicant KENT RIDGE DIGITAL LABS et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheet(s).

3. This report contains indications relating to the following items:

- I Basis of the report
- II Priority
- III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV Lack of unity of invention
- V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI Certain documents cited
- VII Certain defects in the international application
- VIII Certain observations on the international application

Date of submission of the demand 2 November 2003	Date of completion of the report 13 July 2004
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer DALE SIVER Telephone No. (02) 6283 2196

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International application No.
PCT/SG2002/000060

L Basis of the report1. With regard to the elements of the international application:^{*}

- the international application as originally filed.
- the description, pages 1-12 as originally filed,
pages , filed with the demand,
pages , received on with the letter of
 the claims, pages 14,16 as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 13,15,17 received on 7 July 2004 with the letter of 7 July 2004
- the drawings, pages 1/5 - 5/5 as originally filed,
pages , filed with the demand,
pages , received on with the letter of
 the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
 the language of publication of the international application (under Rule 48.3(b)).
 the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- contained in the international application in written form.
 filed together with the international application in computer readable form.
 furnished subsequently to this Authority in written form.
 furnished subsequently to this Authority in computer readable form.
 The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
 The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. The amendments have resulted in the cancellation of:

- the description, pages
 the claims, Nos.
 the drawings, sheets/fig.

5. This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under Item 1 and annexed to this report

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V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-37	YES
	Claims	NO
Inventive step (IS)	Claims 1-37	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-37	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

- D1 EP 806739 B1 (LUCENT TECHNOLOGIES INC.) 22 January 2003 (A level published 12.11.1997)
 New Citations
 D2 Wen J. et al. "Face recognition method based on virtual sample" 29 October to 11 November 2001 ICII 2001. International Conference on Info-tech and Info-net 2001
 D3 Beymer, D. "Face recognition from one example view" 20-23 June 1995 IEEE Proceedings Fifth International Conference on Computer Vision

Novelty (N)

D1 is considered the closest prior art identified in the ISR, and discloses face recognition using DCT-based feature vectors. The method of matching a given object with a plurality of known objects uses a database and a corresponding codebook. Claim 1 (of the present application) defines a face recognition system including registering a persons actual face (also creating a plurality of face prototypes). Therefore claim 1 is novel in light of D1.

D2 discloses virtual faces and a face recognition algorithm. D2 also discloses (explicitly) that the virtual faces represent different orientations (or poses). D2 describes a face feature dependent method for generating the virtual faces, wherein the actual face image must be at a known pose. The present claims do not restrict the actual face image to a known pose, which confers novelty on the claims in view of D2.

D3 also discloses face recognition including virtual views of faces that are based on a single example view. The views include a standard pose and transformed poses. However, similar to D1 and D2, the actual face image is not normalized prior to prototype faces being generated therefrom during image registration. Consequently the method is new because although the citations mention normalization of the novel face (ie. the sample to be compared) they do not disclose normalization of and transformation of the actual face prior to registration in the database (ie. to generate and store the virtual views in the database). D3 requires one real view at a known pose, and the present claims define that the image of the person's actual face is normalized by applying at least one of translational, rotational and scalar transformations. This difference confers novelty on the claims.

Inventive step (IS)

In section 3.2.1 of D3 it is suggested to use normalized correlation with example templates. In contrast, the applicant's invention seeks to obtain a good reference database by correcting image errors via normalization during registration and creation of the database, instead of during the face recognition stage.

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Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of Box V (Inventive Step)

The new method would not be obvious in light of D3 for example, where a similar normalization occurs (see section 3.2.1 and Figure 2). The parallel deformation is performed after feature extraction on the input view. The input is repetitively matched against all example views of all people. Matching involves a geometrical registration step and correlation. The geometrical registration involves transformation of the input view (using extracted features such as iris and nose lobe). The D3 database contains 15 real example views of each person to handle pose invariance. The one real view and multiple virtual views of the face to be recognised are then compared with the multiple real view information previously stored in the database.

A person having ordinary skill would not be lead to normalize the actual face images before putting them in the database (as presently defined in the amended claims). D3 teaches to store multiple real views to handle pose invariance. None of the other citations suggest correcting the database using normalization (as part of the image registration procedure).

The term "face prototypes" has been interpreted to imply that *a previous step including registering a person's actual face wherein an image of the actual face is captured and synthesized to create a plurality of face prototypes, and wherein the face prototypes are stored for later analysis and comparison with a captured image to be recognised or verified* has been part of the creation process for the face prototypes. This interpretation is based on page 3 lines 2-7 and reading the description as a whole. Hence the claims are interpreted to define that the face prototypes are created from one real image and are stored for later use.

All of the claims satisfy PCT requirements for inventive step.

Industrial applicability (IA)

The claims have an industrial application (ie. face recognition database correction).

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CLAIMS:

1. A face recognition and/or verification system including the step of registering a persons actual face wherein an image of said actual face is captured and synthesized to create a plurality of face prototypes, wherein said 5 face prototypes are stored for later analysis and comparison with a captured image to be recognised or verified, and wherein at least one of translational, rotational and scalar transformations is applied to the captured actual face image for normalization thereof.
- 10 2. The system as claimed in claim 1 wherein said face prototypes represent possible appearances of said actual face under various lighting conditions, varying facial expressions, varying facial orientations, and/or modeling errors.
- 15 3. The system as claimed in claim 1, wherein comparison of said face prototypes and captured image uses a face matching algorithm.
4. The system as claimed in claim 1, wherein comparison of said face prototypes and captured image uses face templates or feature vectors.
- 20 5. The system as claimed in any preceding claim, wherein synthesizing of said actual face includes normalising said actual face image based on the spatial relationship between at least two features of the actual face image.
- 25 6. The system as claimed in claim 5, wherein normalising includes rotating said actual face image to bring eyes of said actual face image to a horizontal plane.
- 30 7. The system as claimed in claim 5 or claim 6, wherein normalising includes scaling said actual face image such that the eyes are a fixed distance apart.
8. The system as claimed in claim 7, wherein said eyes are fixed at 50 pixels apart.

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19. The system as claimed in claim 16, wherein said photometric transform includes at least one of:
algorithmic function, exponential stretch, vertical shadow,
5 horizontal shadow and differentiating image.
20. A facial prototype synthesis system wherein an image of a persons actual face is initially normalized by applying at least one of translational, rotational and scalar transformations thereto for subsequently creating a plurality of face prototypes, said face prototypes representing possible appearances of said actual face under various lighting conditions, varying facial expressions, varying facial orientations, and/or modeling errors, and wherein said face prototypes are stored for later use
- 10 21. The system as claimed in claim 20, wherein said actual face image is normalized prior to creating said face prototypes based on the spatial relationship between at least two features of the actual face image.
- 20 22. The system as claimed in claim 21, wherein normalising includes rotating said actual face image to bring eyes of said actual face image to a horizontal plane.
- 25 23. The system as claimed in claim 21 or claim 22, wherein normalising includes scaling said actual face image such that the eyes are a fixed distance apart.
- 30 24. The system as claimed in claim 23, wherein said eyes are fixed at 50 pixels apart.
- 35 25. The system as claimed in any one of claims 20 to 24, wherein the area above the persons eyebrows and below the persons mouth is not synthesized.
26. The system as claimed in any one of claims 20 to 25, wherein to create said face prototypes said system determines alternative positions for each eye so as to compensate for possible errors.

9. The system as claimed in any preceding claim wherein the area above the persons eyebrows and below the persons mouth is not synthesized.
10. The system as claimed in any preceding claim wherein synthesizing of said actual face includes determining alternative positions for each eye so as to compensate for possible errors.
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11. The system as claimed in claim 10, wherein five alternative positions are determined for each eye.
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12. The system as claimed in any preceding claim wherein synthesizing of said actual face includes applying at least one predefined lighting mask to said actual face image.
13. The system as claimed in claim 12, wherein three to 16 predefined lighting masks are used.
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14. The system as claimed in any preceding claim wherein synthesizing of said actual face includes applying at least one predefined warping mask to said
20 actual face image.
15. The system as claimed in claim 14, wherein 25 predefined warping masks are used.
16. The system as claimed in claim 12 or claim 13, wherein said at least one lighting mask includes photometric transform.
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17. The system as claimed in claim 14 or claim 15, wherein said at least one warping mask includes geometric transform.
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18. The system as claimed in claim 17, wherein said geometric transform is estimated using optical flow estimation.

27. The system as claimed in claim 26, wherein five alternative positions are determined for each eye.
- 5 28. The system as claimed in any one of claims 20 to 27 wherein to create said face prototypes said system applies at least one predefined lighting mask to said actual face image.
29. The system as claimed in claim 28, wherein three to 16 predefined lighting
10 masks are used.
30. The system as claimed in one of claims 20 to 29 wherein to create said face prototypes said system applies at least one predefined warping mask to said actual face image.
- 15 31. The system as claimed in claim 30, wherein 25 predefined warping masks are used.
32. The system as claimed in claim 28 or claim 29, wherein said at least one
20 lighting mask includes photometric transform.
33. The system as claimed in claim 30 or claim 31, wherein said at least one warping mask includes geometric transform.
- 25 34. The system as claimed in claim 33, wherein said geometric transform is estimated using optical flow estimation.
35. The system as claimed in claim 32, wherein said photometric transform includes at least one of:
30 algorithmic function, exponential stretch, vertical shadow, horizontal shadow and differentiating image.

36. The system as claimed in claim 20, wherein said face prototypes are generated by applying photometric and/or geometric transforms to said image.

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37. A facial prototype synthesis system wherein an image of a persons actual face is normalised by applying at least one of translational, rotational and scalar transformations to the captured actual face image, and synthesized by determining possible alternative eye positions and applying at least one mask to said image to create a plurality of face prototypes, and wherein said face prototypes represent possible appearances of said actual face under various lighting conditions, varying facial expressions, varying facial orientations, and/or modeling errors.
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